

Two at the station from which the balloon is being released (the home station).

One at the other station (the distant station).

Two in the office computing.

At the home station, one of the observers follows the balloon. The other, who is at the telephone, gives the needful time signals and transmits the observations of his own station to the office: the observer at the distant station transmits his own observations on hearing the time signals given by the home observer. To prevent any confusion, the routine adopted is for the distant observer to send his readings through first, and for the home station to send theirs immediately afterwards.

In the office there are two computers. The one who is wearing the telephone receives the observations and notes them on the special form, at the same time giving them

verbally to the second computer, who plots them on his radial chart and reads off the values Height/600, wind speed and direction. He gives these to the first computer, who enters them on the form and, by means of the slide rule, calculates the height of the balloon above each station. The necessary computing is done before the reading for the next minute becomes due. Thus the whole work can be done during the balloon ascent, and results are obtained just as rapidly as with single-theodolite observations.

Telephone connections are available at each angle of a triangle, which is nearly equilateral, with sides which are about 4,000 feet long. The base used may be any one of the sides of this triangle, and the particular side to be used is that which will be most nearly at right angles to the path of the balloon.

FREE-BALLOON FLIGHT IN THE NORTHEAST QUADRANT OF AN INTENSE CYCLONE.

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[Dated: Fort Omaha, Nebr., Mar. 26, 1919.]

At 3:37 on the morning of March 14, 1919, the writer participated in a free-balloon flight from Fort Omaha, Nebr. The balloon had a capacity of 35,000 cubic feet and carried a party of five, piloted by Lieut. Ralph A. Reynolds. Owing to a somewhat gusty east wind, which seemed to bear the balloon down upon the ground, the oscillations of the bag were so severe as to cause the basket to crash into the ground on the getaway, rendering the barograph useless. Nevertheless, the whole experience was one of beauty—the full moon above the fog billows, the sunrise, and finally the landing in the fog. At 9:10 a landing was effected in a field about 8 miles southeast of Geddes, S. Dak.—an air-line distance of 322 kilometers from the starting point.

Table 1 is a summary of the flight:

TABLE 1.—Record of free-balloon voyage, Mar. 14, 1919.

Time.	Altitude (altimeter set 0 at Fort Omaha).	Probable direction of travel.	Temperature. ¹	Remarks.
A. M.	Feet.		° F.	
3:37	1,750	W.	30	Above clouds.
3:47	1,750	N.	30	Do.
4:07	1,800	N.	30	Do.
4:22	1,850	N.	30	In clouds.
4:37	1,850	NW.	26	Do.
4:52	1,850	NW.	26	Do.
5:07	1,850	NW.	26	Do.
5:22	1,900	NW.	26	Do.
5:37	1,950	NW.	26	Do.
5:52	1,800	W.	22	Do.
6:07	1,825	W.	21	Do.
6:22	1,050	W.	28	Trail rope touched ground at about 6:30
6:37	1,700	W.	30	In clouds.
6:52	850	W.	30	Above clouds.
7:07	700	W.	32	Do.
7:22	900	NW.	32	Above clouds; first appearance of sun.
7:37	900	NW.	38	Above clouds.
7:52	1,400	NW.	38	Do.
8:07	1,750	NW.	38	Do.
8:22	1,750	NW.	38	In clouds.
8:37	1,000	NW.	38	Do.
8:52	1,000	NW.	26	Do.
9:10				

¹ Thermometer of cheap commercial make.

² Left ground.

³ Altimeter reset by about 1,100 feet after trail rope touched ground.

⁴ Temperature uncertain, as thermometer was not shielded from sun.

⁵ Landed 8 miles southeast of Geddes, S. Dak.

First, let us consider the pressure distribution on the morning in question, namely, March 14. (See fig. 1.) There was an area of high pressure over eastern Canada and a low-pressure area centered in northern Colorado.

The gradient was quite steep, due to a pressure difference of over 50 millibars (observed difference 1.68 in.) between the two centers. The isobars of the Middle West were almost parallel in a northwest-southeast direction. Because of this steepness of gradient, high winds in this region were to be expected. During the day the center of low pressure moved in a northeasterly direction, and in northern Nebraska there were very high winds, accompanied in the afternoon by terrific hailstorms and, in several places, by small tornadoes. This leaves little doubt as to the eddying and somewhat turbulent state of the atmosphere in this vicinity.

On the morning of the departure the wind was easterly on the surface and quite gusty. The sky was overcast

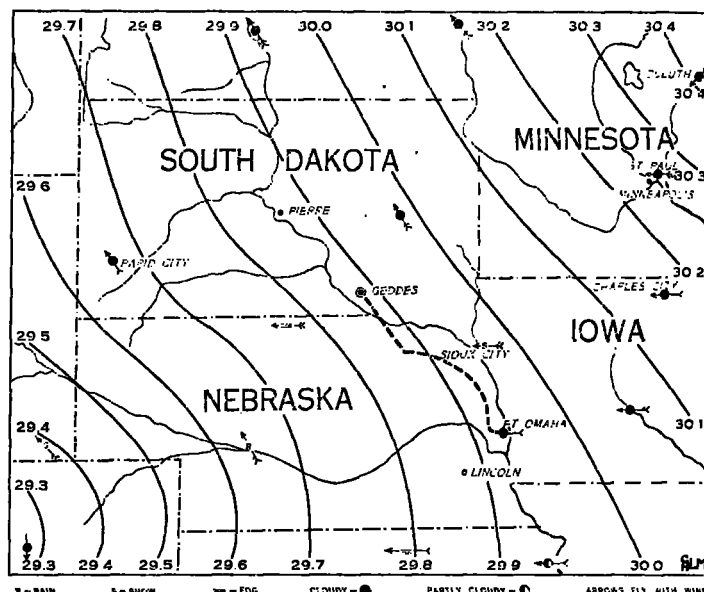


FIG. 1.—Weather map, 7 a. m., 90th meridian time, Mar. 14, 1919; and probable route taken by the balloon.

with a very low stratus sheet, the base of which was not over 300 feet above the ground. As nearly as could be judged, these clouds were moving about 9 meters per second from the east. The balloon, of course, left the ground moving west and maintained this direction while passing into the clouds. Quickly passing through the cloud layer, for it was not very thick, we encountered

a new stratum of air moving in a new direction and with considerably greater speed. The sky above was clear. In the southwest the full face of the moon, orange-colored, beamed over the soft blue-gray fog billows. Our new direction and speed were evidenced by two phenomena:

First, the flags suspended from the rigging suddenly began to whip about quite violently; and

Second, the clouds below appeared to be traveling at a tremendous speed away from us and directly toward the moon.

The first phenomenon, which is very common in ballooning, indicates the turbulence which is present at the interface of two layers of air. The second can be proved to show that we had assumed a new direction, namely, north. It seems probable that the direction of motion of the upper surface of the stratus cloud was toward the northwest; that is, parallel to the isobars, a direction which the gradient wind would take. The apparent movement of the clouds was toward the west-southwest, which could be accounted for by the movement of the balloon northward.

About half an hour after rising above the low stratus cloud, we began to settle into it. More and more frequently we encountered huge mountains of fog, until finally we were completely enveloped by it. Even the gray bag overhead was scarcely to be discerned. One can not conceive of a more perfect picturization of the word "void." Above, below, and on either hand lay an ocean of soft, neutral nothingness. Indeed, the words, "Abandon hope, all ye who enter here," were constantly recalled to our minds. We drifted thus for about two hours and one-half, with the altimeter reading between 1,500 and 2,000 feet.

Yet there was no monotony, for, in spite of the dreary aspect of the surrounding medium, there was a startling clearness to the crowing of the roosters and to other farmyard noises. But we dismissed this clarity and intensity of the sound as being due to the moist air. Our complacent satisfaction with the situation was disturbed, however, when there came dangerously near to our ears the regularly recurring "squeak, creak, squeak, creak" of a windmill.

The sun was not up yet, but already the morning light was beginning to be diffused through the gulf of suspended moisture in which we were traveling. We were watching intently over the basket edge, when swiftly a patch of something white shot below with dizzy speed, and then another, and another. "Water" some one suggested. "Clouds," suggested the meteorologist, adding with the foresight of his profession that it was unusual to see that type of clouds so low. Nevertheless, there they were—long, wavy lines of white clouds. The statoscope showed that we were falling, a fact which, in itself, was not of great consequence. But just at that moment the balloon gave a heave and a jerk. A fence post was whisked off its feet, and we went on. Here was a cornfield, with lines of partly melted snow between the rows. The drag-rope was whipping over the ground, yet the altimeter read 1,200 feet. Either we had come into territory very much higher than Fort Omaha or our altimeter had suffered like the barograph in the getaway. A bag of sand overboard sent us back into the fog. The pilot reset the altimeter by about 1,100 feet and we felt considerably easier concerning our altitude.

By this time the sun was rising, and with its appearance we were permitted to witness such a scene of beauty as no one can dream of who has not explored the wonders

of the upper air. It defies description. It was such a scene as Maeterlinck might employ in transporting a mortal to another world. Below lay a gently undulating sea of fog, soft as down and delicately tinted as mother-of-pearl. Above, with apparent motion scarcely perceptible, floated a layer of alto-cumuli opaled by the rising sun, and ever varying in iridescent splendor. The upper clouds were beginning to dissipate under the sun's rays, and, as they melted away, the sun itself burst forth casting the balloon's shadow far away onto the fog bank, and gave the fog below a softer, rosier, more vaporous appearance. The fog, also, was beginning to succumb to the morning heat.

Our hopes for a little while were high, thinking that the fog would shortly be dispelled by the rising sun. A little bird came winging out of the mist like the dove to the travelers in the ark. After a short visit, he returned to the void beneath and was not seen again. In the southeast and south appeared a great blue bank of threatening strato-cumuli. They were approaching us, or we them, at a terrific speed. This occurred at 7:20 and was accompanied by a rotation of the balloon in such a manner that the sun, instead of being on our right, was now on our left, indicating, perhaps, that we were facing the southwest, whereas, but a few minutes before, we had been facing the northeast. In a short time the sun was obscured by the onrushing clouds, and in the clear space between the smooth-topped fog and the layer of strato-cumuli we found ourselves once more completely isolated from the world or any sign of life.

There is a phase of free ballooning upon which it seems difficult to get light from balloonists; namely, does the trail-rope dangling from the side of the basket afford an axis of rotation for the balloon? Apparently it does. For example, when the balloon is released, it is generally so turned that the trail-rope is on the windward side of the basket. It has been noticed that when the balloon experiences a change of direction the trail-rope continues to follow the balloon; or, more precisely, that the entire balloon turns in such a manner that the rope is on the side from which the wind is blowing. Or, if the lower end of the trail-rope is in a wind of different direction, perhaps the rope will remain on the side of the basket from which the wind is blowing relative to the wind below.

When the sun rose, we were facing the northeast although the balloon was probably moving slowly toward the northwest. The expansion and heating of the gas carried us up and probably into a new current, for at 7:20 we experienced a clockwise rotation through about 210°, as indicated by the position of the sun, so that we now faced the west-southwest. We were now traveling rapidly, probably still from the southeast.

All hope of the fog lifting was now abandoned and a landing was imperative. Being entirely ignorant of our position, however, the valving had to be effected very delicately. We came down slowly, unable to see the end of the trail-rope, so dense was the fog. We felt the rope touch, and, in a moment, patches of snow were seen to slip below with alarming rapidity. We came low enough to see that we were over ice. Afterward we learned that it was Lake Andes, which has a surface of over 30 square miles. Ballast was thrown so that we were soon back in the fog. In a few minutes a second and more successful attempt to land was made. This time we identified a straw stack and a fence and began a very rapid descent. Within 150 feet of the ground there occurred what seemed to be a complete reversal of wind direction, for what we presumed to be the same

straw stack we had seen the moment before came rushing back at us. This point is not clear, however, and there is a difference of opinion among the members of the party. About half an hour after we landed, a thunderstorm broke upon us, giving a heavy precipitation of rain, snow, and hail. The wind during the occurrence of the heavy precipitation seemed to come from the east-southeast. It is possible that we were caught in the squall ahead of the thunderstorm, and this may have been responsible for the capricious conduct of the balloon just before landing.

It may seem that this discussion of our probable path is based upon rather uncertain evidence. Yet, in spite of the fact, I feel very confident of the conclusions. Apparently the distance traversed by the balloon was about 400 kilometers. This yields an average speed of about 20 meters per second. About 12 hours after the journey began, the Drexel, Nebr., Aerological Station obtained a wind of 31 meters per second from the south-southwest at an altitude of 500 meters. Wind speeds of from 10 to 15 meters per second were recorded at the Ellendale, N. Dak., Aerological Station during the time that we were in the air, although we do not have data from that station for the altitudes at which the balloon rode. The projection of our path, then, seems entirely in accord with all the observed phenomena of the trip. There is a very decided charm about being suspended in the air, especially when one is uncertain as to his location, and when one does not know his speed. This journey did more than provide those thrills; it enabled us to actually penetrate and become a part of the wind circulation of a strong cyclone.*

WEATHER DURING SOME NOTABLE AIRSHIP VOYAGES.

(1) In an account of the 4,500-mile trip of the German Zeppelin, *L 59* from Bulgaria to the Sudan and return, one of the crew makes the following mention of the weather:

"While we experienced on the afternoon of November 23 [1917], at an altitude of 7,500 feet [over the Libyan desert south of the oasis of Farafrah], a temperature of 32° C., and wore tropical uniforms, ten hours later we had to put on our leather suits, as the temperature had dropped to 12° C. [near (?) the Nile Delta]."—Abstract from *Aviation*, Mar. 1, 1919, pp. 158-159.

(2) In a trip of a large dirigible from Rome to England, October 29 to November 1, 1917, much unfavorable weather was encountered. From Rome to Marseilles, "very bumpy weather was experienced over Civita

Vecchia [west coast of Italy], and later on a rainstorm was encountered." In the stage from Marseilles to Paris "there was a head wind against which they made poor progress."—Abstract from *Aviation*, Mar. 1, 1919, pp. 158-159.

(3) "In spite of encountering rain, high winds, snow, and extremely low temperatures in cruising up and down the [Atlantic] coast [of the United States], February 26-28, 1919, Ensign C. W. Tyndall established a new endurance record for the nonrigid type of balloon, remaining aloft for 33 hours and 6 minutes."—*Aerial Age Weekly*, Mar. 3, 1919, p. 1265.

(4) A record airship voyage, and what is described as one of the most notable cruises ever undertaken by airship, was accomplished over the North Sea by *N. S. 11*, one of the British non-rigid type. The voyage took the form of a circuit, which embraced the coasts of Denmark, Schleswig-Holstein, Heligoland, North Germany, and Holland, and the most unfavorable weather conditions were met with. The total length of the round trip was 1,285 miles, and the time occupied was 40½ hours.

"The important point about this cruise is not only the distance covered and the long time the vessel was afloat, but her airworthiness in conditions of the most trying character. Starting from the Firth of Forth at 3.45 p. m. on March 18, the first 280 miles were covered easily with only a departure of about a mile from her course. Gradually the wind grew stronger and rougher, and when one engine broke down it seemed doubtful whether the ship could reach the English coast. When, however, it did finally reach the north foreland, petrol was running short owing to the necessity of running at full power earlier in the voyage, and one engine only was running, this on five cylinders out of six."—*Aeronautics*, Mar. 27, 1919, p. 328.

(5) The naval dirigible *C-5*, which made a successful flight from Montauk Point to St. Johns, Newfoundland, May 14-15, remained in the air continuously for 25 hours and 40 minutes. This flight of 1,115 miles nearly equaled the above record for non-rigid airships for total distance covered without a stop. In speaking of the flight, Lieut. Commander E. W. Coil said: "Our troubles started just after midnight, when the sky became overcast. Before then we had been flying under a full moon at an altitude of 1,000 feet. We lost our bearings while approaching Little Miquelon Island, off the south coast of Newfoundland, about 170 miles from St. John's. We made a 'landfall' at St. Pierre, * * * [and went] 'cross lots' to * * * St. John's. * * * There was considerable fog, but it did not trouble us." A perfect landing was made. Later, the dirigible breaking away a second time in a gusty wind, drifted out to sea and was lost.—Abstract from *Aerial Age Weekly*, May 26, 1919, p. 533; and *Aviation*, etc., June 1, 1919, pp. 475-476. (Further notes will appear in the May REVIEW.)—C. F. B.

*The meteorological results of the flights of two balloons, starting from Fort Omaha, at the same time, one attempting to hold an altitude of 5,000 feet, and the other 10,000 feet, will be published in a later issue of the REVIEW.—ED.